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AUTOMATIC WRITING

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I. INTRODUCTION

The purpose of the investigation under consideration was, if possible, to obtain samples of automatic writing in order to determine (1) Under what conditions such writing appears, and (2) What changes take place in the appearance of writing as it becomes less and less controlled.

The first problem involved a study of the mental make-up of a given reagent relative to the scope of attention, tendency to automatism, nature of the inner speech, etc.

The second problem would include a comparison of the writing produced under distraction with the normal writing of a given reagent with reference to many different writing-factors such as size, alignment, slant, line-quality, form and the like. Such a comparison is highly desirable in connection with the study of handwriting for diagnostic purposes since it is of prime importance to know what changes appear as writing becomes progressively uncontrolled. Such a knowledge would also be of value in investigating the alleged shifts of handwriting individuality in mediumistic writing.

In order to obtain material for discussion of the above-stated problems the following experiments were tried:

I. Preliminary experiments, reagent took dictation and wrote sentences or answered questions while reading silently.

II. Reagent wrote a given verse, perfectly memorized, continuously, during the silent reading of the chapters of a novel.

III. Reagent wrote a given verse, perfectly memorized, during the continuous adding of columns of figures.

IV. The reagent wrote, continuously, a given verse, perfectly memorized, while reading aloud.

V. The reagent wrote from dictation (1) while reading aloud, (2) while reading silently.

In reporting our results we confine ourselves to their bearing upon the first problem stated.

Before a detailed account is attempted of the conditions holding in the different series of experiments, a general statement of the conditions that were constant throughout the whole may be given. The experiment ran continuously for seven months (with the breaks incident to college organization), occupying an afternoon session from one to two hours long for five days in the week. The two writers of the paper (A and D) served in turn as reagents.

The reagent in every case sat to the left of a black screen, in the lower half of which was a loose sleeve for the arm opening toward the right in such a fashion that when the hand and arm had been run through it, they were perfectly concealed from the reagent and rested comfortably and without constraint upon the writing-pad which lay on the table, to the end of which the screen was clamped. The experimenter sat to the right of the screen by the table. He was, therefore, out of the reagent's sight. His part in the experiment consisted in manipulating the writing-pad, timing by means of a stop-watch the writing of the reagent, and taking down at set intervals the introspections of the reagent. The writing was done, in part, in pencil, in part, in ink.

A few words as to the reagents. Neither shows any striking automatic tendencies, neither is absent-minded, both are averse to "letting themselves go" and maintain control to a high degree. Both show certain perseverative tendencies, are apt to be obsessed by their work, have difficulty in getting to sleep, etc.

Whatever automatisms appear for D would seem to be sensory in character. D has little control over her imaginal processes and is often greatly surprised by the course of her images, she is strikingly "intuitive" in certain lines of work. With this there goes a consciousness of movement to an extraordinary extent so that D is able to inhibit motor expression to an unusual degree. She is a "bad subject" for the muscle-reader. Such inhibition of effort and excess of control are evident in her handwriting which is small, labored, and self-conscious. Sudden impulses leading to excessive

movement occur, however, at intervals and under certain physical conditions D's writing becomes free, fluid, and large.

A is very easy and rapid in his movements, his writing is unusually rapid and smooth in impulse, although slightly illegible. He cuts strokes and ignores the visual appearance of his letters. Attention is focused on meaning, leaving graphic details to habit. A is an excellent subject for the muscle-reader. He reports at times, however, muscular cramp.

While A's writing movements are much freer and smoother than D's, there is some evidence of greater vocal-motor ease for D; thus D's speed in reading aloud is slightly higher than A's, although A was much the more rapid in silent reading. D was able to vocalize mentally more rapidly than could A.

Both reagents show considerable scope of attention¹ and considerable rapidity in work. A's rapidity in executing and synchronizing two processes would seem to be quite exceptional. A great number of tests have shown that he is capable of sustained and effective attention. D's attention is more apt to wander, she was less successful than A in maintaining the double processes at high speed; to some extent this result may be due to her failure to turn over motor details to habit. She maintains a constant supervision over them with this consequence that she makes very few word or letter lapses in comparison with A but when she does make a lapse, it is much more significant of automatism than are A's.

II. PRELIMINARY EXPERIMENTS

These experiments were tried mostly in the spring of 1913 that we might get some idea of the task in hand and some preliminary practise. At first the reagent simply made loop- or roof-strokes continuously while reading silently. After a few trials both of us were able to do this without any effort. Then the reagent tried taking dictation while reading to himself. The reagent began reading and continued making loops until the experimenter dictated a sentence, a word at a time. He wrote this sentence repeatedly until the experimenter dictated another. The record of reagent A is given to illustrate what happened.

A did not find this task at all difficult introspectively. An

¹ In part, we judge this from their reading-rate. Dearborn writes, "A wider 'spanning' of attention,—as denoted both by the greater frequency of long pauses at the beginning of the line and by fewer fixations per line,—is characteristic of the more rapid readers." *The Psychology of Reading, Arch. of Phil., Psychol. and Sci. Methods.* 1903, 122.

estimate of his reading-rate showed, however, that it dropped from an average normal of 10.67 words per second to 6.32 per second. There appeared to be an increase in writing rapidity just after a sentence was dictated with a gradual decrease in speed and increase in number of lapses as time went on before a fresh dictation. Lapses of letter-repetition and of omission of letters occurred with, also, substitutions of words from a preceding sentence. In one record a whole line was interpolated, made up, probably, from words persisting from preceding dictations. In part, this line seemed written without consciousness of writing it.

It was found that if the sentence dictated was in the form of a question, a definite "set" was aroused with considerable impulse to answer the question. We tried, therefore, a series of tests in which the reagent while reading to himself answered questions asked by the experimenter.

Both reagents reported that with practise it became progressively easier to maintain such a "double set." A, however, succeeded much more completely than D in carrying on a conversation. D, for the most part, wrote very simple and stereotyped answers while A produced elaborate sentences. For both reagents, the speed of reading fell considerably below the normal. A few words with reference to the reactions of each subject may be of value.

Five different tests at five different times were tried with A. His average reading-rate (words per second) under distraction was as follows: (1) 5.27, (2) 4.76, (3) 7.01 (answers relatively simple), (4) 5.72, (5) 4.86. His reading-rate was lower except in (3) than when he was simply taking dictation and much lower than his normal reading-rate. It is, however, a good speed in itself and seems remarkably rapid when taken in connection with the long and involved answers written in answer to the experimenter's questions.

Probably there was tendency for the reading to become more automatic than the writing. A reported that the reading became visual in places and that he got a good idea of the story but had little memory of details. Lapse of consciousness came when phrases or words were repeated while A was waiting for a new question. But, on the whole, there was fairly complete consciousness of what was being written. Breaks occurred when A was "tangled up" in the story. When he was very much interested in the story writing went easily. Many lapses of repetition or omission of letters occurred.

Five tests of the same sort were tried with D also. Her

average reading-rate (words per second) under distraction was as follows: (1) 4.17, (2) 3.02, (3) 4.49, (4) 3.8, (5) 3.21. Her normal reading-rate was about seven words per second. At first, as was said before, D's answers were very simple. She wrote "yes" or "no" if possible; otherwise, "Can't tell," "Don't know" or some other simple reply. As the task became easier with practise she attempted more ambitious answers. Lapses were much less frequent than in the case of A but certain stereotyped ones appear. Thus, "known" is constantly written for "know" without D becoming conscious of the error. "No one" is written for "nothing."

She reported that it was easier to put attention on reading than on writing but that she knew what she was writing. "More like split consciousness than unconsciousness." Answers to questions were first framed in inner speech but there was no need of vocalizing "yes" or "no." Hard questions inhibited both processes. In one place the question was heard indistinctly but answered correctly. In the last two tests there was much evidence of increasing automatism for the writing. D, while still conscious of the words written, lost consciousness of the individual letters. Once or twice she started an answer without knowing what she was going to write. There was less control and more spontaneity.

It is interesting to note that although an interval of more than three months intervened between the second and third test in this series, on account of the summer vacation, there was no loss in skill in manipulating the two processes for either reagent. We found, in general, that the practise-effect so noticeable in the work in the spring had held over when we returned to the experiments the following fall.

III. SILENT READING AND WRITING

Method. In this series of experiments the reagent wrote the given verse ("Thirty days hath September," etc.), continuously until he had finished reading the chapter of a novel. The experimenter shifted the sheets of paper so that only one verse was written on a sheet. The subject held the book conveniently in his left hand, with his right hand in position on the writing-pad on the other side of the screen. At a signal from the experimenter the writing and reading began, simultaneously so far as the reagent could manage it. At the signal for beginning the experimenter started two stop-watches. The whole time required for reading the chapter was obtained from

one stop-watch, the time required for writing each verse was obtained from the other. A and D served as reagents.

Toward the close of this series two normals were taken each day for the speed of writing the verse. One normal was taken with the screen under the same conditions as held during the distraction experiment, the other was taken without the screen under the usual writing conditions. In all normals the highest possible speed was maintained.

Normals for the rapidity of silent reading were also obtained at intervals. No attempt was made to test in detail the memory of what was read under distraction but the reagents were instructed to get the meaning. Both followed the story as in ordinary reading for pleasure without much difficulty. Their memory of the novels read is perhaps, after an interval of some months, more complete than is usually the case with casual reading.

The method here followed does not permit any exact equating of the amount read and written at any particular time. It was possible for reading and writing spurts to occur alternately. In the later work there is, however, a record of the amount read for each verse.

Results. The results are given in tabular form in Tables I and II. Table I summarizes the results for the reading of Mrs. Ward's "The Mating of Lydia" from the eighth chapter on. The reading of London's "The Abysmal Brute" and the reading of "The Game" by the same author were each completed in one long session and reading-normals were obtained for alternate chapters. The verses written while the reagent read "The Game" were done in ink, otherwise, the writing was in pencil.

A glance at the tables shows that A both wrote and read normally at a higher speed than did D. For both reagents there is an increase in the speed of the normals with practise. The normal with the screen was found to be slightly more rapid than that without so that the normals given with "The Mating of Lydia" are a trifle too high.

The normal reading-rate also shows a tendency to increase; such an increase was noticed for each story separately. The maximum speed is usually attained at the climax chapter.

The normal reading-rate under distraction shows a fairly constant increase, indicating the practise effect. The writing under distraction also shows increasing speed. D's average speed per verse dropped from 91.33 seconds to 63.66 seconds, A's, from 57.58 seconds to 41 seconds.

In order to assure ourselves of the simultaneity of the two processes, we hoped to get the average speed of both reading and writing under distraction down to the normal rapidity. The experiment, however, consumed so much time that we found it necessary to content ourselves with an approximation of the normal speed or with obtaining a record as low as the normal in an occasional verse. Toward the end of the series A's writing speed approximated the normal very closely. His record speed in this series for both normal writing and writing under distraction is 39 seconds. It should be noted that his reading-speed with the latter record is also high. (See Chap. VI, "The Abysmal Brute.") A's reading-rate under distraction also approached his normal. His introspective reports would seem to show that his reading became more and more visual as the test proceeded.

TABLE I
SILENT READING AND WRITING

Reagent	Date	“ Mating of Lydia ”	Pages ² Read per Minute		Time of Writing Verse in Seconds				No. of times written
			Normal	Distraction	Normal ³	Distraction			
		Chap.				Av.	Min.	Max.	
D	Oct. 10	VIII	.....	.53	.....	89.38	71.0	116.0	16
	Oct. 13	IX	.....	.82	.....	91.33	83.0	107.0	15
	Oct. 15	X	1.62	.....	.....	.....	.....	.....	.....
	Oct. 16	XI	.....	.78	.....	76.56	64.8	90.0	22
	Oct. 16	XII	1.40	.....	.....	.....	.....	.....	.....
	Oct. 17	XIII	1.42	.....	.....	.....	.....	.....	.....
	Oct. 20	XIV	.....	1.01	60.6	78.06	67.0	91.0	17
	Oct. 21	XV	.....	.84	63.2	79.54	64.4	94.0	20
	Oct. 23	XVI	.....	1.00	59.5	76.71	63.4	92.3	17
	Oct. 23	XVII	.....	1.38	.....	71.15	62.0	83.4	12
	Oct. 23	XVIII	1.66	.....	.....	.....	.....	.....	.....
	Oct. 27	XIX	.....	1.14	54.4	71.51	62.4	84.2	17
	Oct. 28	XX	1.64	.....	57.0	.....	.....	.....	.....
	Oct. 28	XXI	.....	1.13	72.40	65.0	79.4	.....	16
	Oct. 28	XXII	.....	.95	72.36	66.0	85.4	.....	23
A	Oct. 13	IX	.....	1.68	.....	57.58	52.0	62.0	12
	Oct. 14	X	1.95	.....	.....	.....	.....	.....	.....
	Oct. 15	XI	.....	1.63	.....	51.02	40.0	57.0	15
	Oct. 15	XII	2.23	.....	.....	.....	.....	.....	.....
	Oct. 16	XIII	1.88	.....	.....	.....	.....	.....	.....
	Oct. 17	XIV	.....	1.75	.....	50.17	42.5	57.0	15
	Oct. 21	XV	.....	1.66	40.0	45.83	41.2	52.9	18
	Oct. 22	XVI	.....	1.80	42.5	48.87	43.6	54.8	14
	Oct. 23	XVII	.....	1.93	41.9	44.57	42.0	46.5	11
	Oct. 23	XXVIII	2.66	.....	.....	.....	.....	.....	.....
	Oct. 24	XIX	.....	2.20	43.5	47.62	44.5	59.0	13
	Oct. 27	XX	2.93	.....	.....	.....	.....	.....	.....
	Oct. 28	XXI	.....	2.31	43.0	44.64	43.0	47.2	13
	Oct. 28	XXII	.....	2.21	.....	42.60	39.0	45.0	16

² About 275 words to the page.

³ Without use of screen.

TABLE II
SILENT READING AND WRITING
Reading—"The Abysmal Brute."—(London)

Reagent	Chap.	Normal		Chap.	Distraction				
		Pages ⁴ per minute	Verse time in seconds		Pages ⁴ per minute	Verse Time in Seconds			No. of times written
						Av.	Min.	Max.	
D	I	3.00	54.2 ⁵	II	1.30	66.65	61.6	78.6	15
Nov. 11	III	2.90	.....	IV	1.66	69.98	68.0	73.2	5
	V	2.61	.....	VI	1.84	71.52	65.8	81.0	16
	VII	2.69	.....	VIII	1.60	71.91	68.6	73.0	7
	IX	2.19	.....	X	1.70	64.27	59.0	67.8	14
A	I	3.36	39 ⁶	II	3.43	42.2	40.2	44.0	9
Nov. 6	III	4.07	.....	IV	3.44	43.7	40.0	46.0	4
	V	3.97	.....	VI	4.23	41.0	39.0	47.5	12
	VII	4.48	.....	VIII	4.67	42.2	41.0	43.8	4
	IX	5.05	.....	X	3.73	42.2	40.0	45.0	10

Reading—"The Game"—⁶—(London)—Ink Records

D	II	2.84	61 ⁶	I	1.25	70.2	61.8	87.2	11
Nov. 20	IV	2.59	.....	III	1.43	63.66	60.0	73.0	6
	VI	2.81	.....	V	1.32	65.66	57.0	71.0	12
A ⁷	II	4.22	42 ⁵	I	3.92	43.75	43.0	44.5	6
Nov. 18	IV	3.30	.....	III	3.77	45.8	44.0	47.0	3
	VI	4.42	.....	V	3.41	45.3	43.0	50.0	7

⁴ About 149 words per page.

⁵ With screen.

⁶ About 132 words per page.

⁷ Bad physical condition.

Introspections. The introspections (more accurately retrospections) given by the reagents are fairly adequate. Both reported, however, that any assumption of the introspective attitude in the course of the experiment complicated conditions badly. At times, in spite of concentration upon the reading, the thought would come "How am I doing this?"

For D another complication entered occasionally in that descriptive bits in the stories read suggested concrete visualizations. An attempt to maintain the three processes, reading, writing, and concrete imagery, caused considerable retardation. In time D was able to inhibit somewhat the tendency to visualization. She had also to inhibit a tendency to pause and think over any generalizations in the stories.

In order to make it possible to trace in some detail the course of the experiment we are giving extracts from the daily introspections chapter by chapter.

First, for D. "The Mating of Lydia," VIII—"All verse-words were mentally heard or vocalized, but as the reading

went on the vocalization became lighter, as it were." IX. "Auditory-vocal-motor cue for every word written. Sometimes this word seems to float over the reading consciousness. Complete loss of orientation of hand, very distressing." XI. "Process getting more automatic. Writing went easily. Auditory-vocal-motor cue for every word but not much kinaesthetic report except of a blurred sort." Certain stereotyped lapses appear as a doubling of the first stroke of "y" and the doubling of "v." D had the feeling of writing these letters correctly. XIV. "Writing went easily. The auditory-vocal-motor cue for verse floats over the auditory-vocal-motor reading. Lost report from 'y's' and 'i's'." Alignment lost completely after fourth record. XV. "Verse went easily after once started. Word by word cue. Toward close the kinaesthetic report began to lapse." A curious lapse appeared at this point. In writing the eighteenth verse D omitted the fourth line. In writing the next verse D repeats this line. D reported neither of these lapses. Toward the close of the nineteenth verse, D reported that she "came to" with a feeling that the word "April" had been written last, although at that moment she was writing another line. She concluded, incorrectly, that the second line had been cut. XVI. "The verse cue is auditory-vocal-motor, word by word. I believe that this word is mentally vocalized during breaks in the reading and that it then echoes in consciousness until written. Perhaps toward the close of each chapter synchronization of reading and writing occurs." XIX. "More automatic than before. Kinaesthetic report goes first. Feeling of irresponsibility as to details. Auditory-vocal-motor cue remains but seems to float over the reading. Sometimes there was an actual doubling of consciousness. Cue was more schematic than before. Meaning dropping out, numerals particularly unmeaning." XXI. "Reading becoming easier and easier to maintain, and writing more automatic. Writing cue persists but is more and more attenuated. Meaning evaporating from verse so that I can't hold my place. Kinaesthetic details gone." XXII. "The reading seems in part visual, in part, the two vocal-motor processes are synchronous. Meaning is evaporating; the lines and words are becoming detached. Lapse of kinaesthetic report very marked. Loss of orientation very distressing." D reported that she would not have been surprised to find lines omitted from the verses. None were omitted.

"The Abysmal Brute." II. "Lost space-relations. No idea where writing is." VI. "Lost connections between lines and

lost meaning of words even while writing them." VIII. "Lost connections within line, puzzled as to what has been written." X. "The writing for this chapter is much more AUTOMATIC than for any other chapter. Loss of strain in arm, usual blurring of kinaesthetic report. The first 'T' is now merely a signal for setting off reaction, it is not thought of as a 'T.'"

"The Game." I. "Distressing. Felt as though the pen were making no record. Kinaesthetic report inadequate and defective." III. "Easy smooth movement but lapsing of all kinaesthetic details." V. "Writing went easily. Verbalized verse throughout."

Secondly, A's introspections. "The Mating of Lydia." IX. "Consciousness of verse high at beginning, then lapsed. Vocal-motor cue throughout but this cue appears to be both marginal and imaginal." XI. "Vocal-motor cue throughout for verse but a rapid running together of words." XIV. "Lost consciousness of writing at one point in reading." "Came to" and found himself writing last line of verse. XIV. "Excessive spurting, excessive movement, many flourishes." XV. "Fairly conscious of verse with verbal cue; second, third, and fourth lines most apt to drop out. Consciousness reduced for these lines." XVI. "Exciting chapter. Vocal-motor verse-cue, line by line. Attention on reading rather than on writing." XVII. "Cue for verse is line by line, for each verse conscious of cue for only two lines, but these lines vary from verse to verse." XIX. "Chapter very interesting, main interest in story." XXI. "Attention on reading throughout. Can't tell about writing-cue. Perhaps a line-cue. Whole line verbalized. Writing and verbalization not synchronized. Very little attention on writing."

"The Abysmal Brute." II. "Cue as for normal writing. Hand report not detailed, only general movement felt." IV. "Attention largely on reading. Toward close of test writing may have become automatic." VI. "Chapter less interesting than before. Writing was less automatic." VIII. "The kinaesthetic report drops out of consciousness. If a word is pronounced, it feels written. General feel of movement is of up and down strokes. Chapter is intensely interesting. Climax of story." X. "Attention mainly on reading. Cue more pronounced at beginning than at close of verse. Probably unconscious of any cue on verse eight or nine."

"The Game." A was in bad physical condition, feverish. I. "Had a little trouble getting into the story because of the abrupt opening. Attention mainly on reading. The kinaesthetic report not detailed, only big sweeping strokes came to

consciousness. Reading was largely visual, a paragraph was taken in at a time with verbalization of occasional words only. No memory of any verbalization of verse, cue gone more completely than ever before, process more automatic." A found that the strain in his hand and arm and the pain in his head (due to condition) vanished from consciousness during the test. III. "Attention came to the writing, there were vocal-motor cues throughout, the reading was largely visual." V. "Interest in reading high. Emotional interest. Attention off writing but would revert to writing suddenly and unexpectedly. Less visual reading than before."

A reports, in general, in regard to the verbal cue for writing the verse, that only when he definitely thinks to notice whether or not it is present at the time of writing is he aware of it. Otherwise memory does not avail to tell whether or not such a cue was present.

IV. SIMULTANEOUS WRITING AND ADDING

Method. This experiment was similar to those above, except that the adding of columns of figures was substituted for the reading. Instead of the verse "Thirty days," etc., the two verses beginning "Little drops of water," etc., were written.

The method of procedure was similar to that in the above experiments. The subject held the slips with the columns to be added in his left hand, while writing the stanzas with his right hand, extended through the black cloth screen. The experimenter, on the other side of the screen, observed the writing process and recorded the time. The subject wrote the two stanzas of this selection through once, adding as many of the columns of figures as possible. The experimenter took the time for writing the whole verse, for adding each column and for adding each problem, making note also of any breaks that occurred in the writing and noticing particularly the effect of announcing results.

Each problem added consisted of nine three place figures. The first 24 problems were taken from the Courtis Standard Arithmetic Tests No. 1. Later, problems were made by changing the order and transferring numbers given in the first 24. These later problems were prepared on an adding machine, the totals being turned under.

Only one subject was used in this test, Subject A. Subject D tried the test several times, but had such difficulty in performing the double operation that the test with her was abandoned. The experiment ran for twelve days, with, at

times, several days intervening between the tests. The longest break was five days, between the first and second tests. A normal writing record for the verse was obtained, both before and after each test, one without and one with the screen. The normals with and without the screen were alternated in order that neither normal might constantly have the benefit of the practise and warming up. On days that ink records were obtained, ink normals were used.

After completing the writing of the two verses, a very full introspective report was obtained from the subject. This introspective report covered the kind and amount of writing cue, the memory of lapses, confidence in the accuracy of adding, and such other things as seemed worthy of comment. At the conclusion of each test, the results of the additions were checked column by column.

At the beginning of the experiment, the subject was able to add only two problems while writing the stanzas once, then with a slight reduction in adding time, he added three problems (which tended to lengthen the writing-time of the stanzas) and then, after several more days, with a great decrease in the writing time, he was able to add two problems only. From the point of return to the two problems to the end of the experiment, only two problems were added during the writing of the stanzas, as both writing and adding times decreased almost simultaneously.

It was found necessary, in order to make the tabular representation of results comparable, to take two-thirds of the total writing time as the basis on which to draw up the tables, in those cases where three problems were solved.

Normal adding times were obtained on four different days.

Results. During the course of the experiment, the writing time for the two stanzas decreased from 122" obtained on the first day to 46" obtained on the last day. The highest adding time for all problems was 78" on the third day and the lowest 18" obtained on the last day. Both of these records were obtained for the first problem. For the second problem, the highest record was 60" on each of the first, second, and third days, and the lowest was 24" on the ninth day. For the third problem, the highest was 65" on the fifth day and the lowest 35" on the same day.

The average adding time under distraction for the first problem was 31.34", for the second, 38.27", for the third 48.60". A third problem was utilized only a few times during the test, so that this high record is not significant. Throughout the experiment, however, the time for adding the second

problem is consistently higher than for adding the first, and the time for the third is higher than for either of the other two.

The average adding time for twenty-one problems under normal conditions was 19.8" with a maximum time of 27" and a minimum time of 15". All of the normal additions were correct. Among the additions performed under distraction, we find that for the first problem 19 were correct and 33 wrong; for the second problem, 17 were correct and 33 were wrong; for the third problem 5 were correct and 10 were wrong; and for the fourth problem, 1 was correct, making in all, 42 correct and 76 wrong additions out of 118 problems. The number of correct additions made is indiscriminately mixed with the number of incorrect, except for one day, the fifth of the test, when eight problems out of thirteen were done correctly.

The average time for the normal verse writing, when the screen was not used, was 46.88" and when the screen was used 45.41". As before, a constant tendency for the writing with the screen (that is, when visual control was absent) to be lower than for the writing without the screen (when visual control was present) was noticed. The average normal time for writing the verse (speeded) with and without the screen was 46.22". The highest normal writing, without the screen, was 53" made on the 5th day and the lowest 42.5" made on the 8th day. The highest normal time with the screen, was 50" made on the first day, and the lowest 40" made on the 12th or last day.

The following table, Table III gives in detailed form the course of the writing side of the experiment. The first two

TABLE III
WRITING TIMES FOR VERSE

Date	Normals		Distraction			
	Without Screen	With Screen	Times Written	Average	Minimum	Maximum
Nov. 26.....	50.5	50.0	1	122.0		
Dec. 1.....	50.4	49.9	2	104.5	97.0	112.0
Dec. 2.....	50.0	46.0	4	96.75	83.0	121.0
Dec. 4.....	50.0	49.0	5	97.40*	86.0*	107.0*
Dec. 5.....	50.7	48.0	3	80.3*	75.0*	86.0*
Dec. 8.....	45.0	46.5	3	71.0*	64.0*	75.0*
Dec. 9.....	45.2	44.0	4	72.75*	66.0*	89.0*
Dec. 11.....	42.75	46.0	7	75.14	63.0	93.0
Dec. 12.....	46.8	44.0	5	63.30	52.0	78.0
Dec. 15.....	43.0	42.5	6	57.33	49.0	66.0
Dec. 16.....	44.0	40.5	7	54.21	49.0	63.0
Dec. 17.....	43.0	40.0	5	49.0	46.0	54.0
General Averages..	46.78	45.53		78.64		

columns show the gradual decrease that was made in the normal writing times, and the last three columns the decrease in the writing times under distraction.

Table IV presents the results that show the gradual decrease in the adding times of the various problems. The last three columns give the general results of all the problems.

TABLE IV
TIMES FOR ADDING PROBLEMS

Date	Times Verse Written	1st Problem			2nd Problem			3rd Problem			All Problems		
		Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.
Nov. 26	1	59			60								
Dec. 1	2	51	47	55	52.5	48	57				51.7	47	57
Dec. 2	4	46	34	78	50.7	49	60				48.3	34	78
Dec. 4	5	35	31	40	51.6	34	60	60	65	53			
Dec. 5	3	34	27	40	40.6	35	50	44	49	35	39.5	27	50
Dec. 8	3	30	30	30	34.3	30	43	44.3	50	37	36.6	30	50
Dec. 9	4	40	28	53	33.2	31	37	41	44	39	38	28	53
Dec. 11	7	32.4	25	43	42.4	35	50				37.4	25	50
Dec. 12	5	26.2	25	28	35.4	24	50				30.8	24	50
Dec. 15	6	25.8	20	33	30.5	25	36				28.1	20	36
Dec. 16	7	23.1	20	28	31	26	40				27.0	20	40
Dec. 17	5	20.6	18	25	28.2	26	33				24.4	18	33
General Averages		35.3			40.9			47.3			36.6		

The next table V gives the results of the normal adding times. The results in this table are to be compared with those given in the preceding table for the adding times under distraction.

TABLE V
NORMAL ADDING TIMES

Date	Problems Added	First Problem			Second Problem			All Problems		
		Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.
Dec. 1	3	22.6	20.8	24				22.6	20.8	24
Dec. 9	2	16.0	15	17				16.0	15	17
Dec. 11	4	19.5	18	21	24.5	24	25	22.0	18	25
Dec. 16	12	17.3	16	20	20.6	17	27	19.0	16	27
Averages		18.6			22.5			19.9		

Tables III and IV indicate gradually increasing proficiency in handling two processes simultaneously. Inasmuch, however, as the record normal writing time for the two stanzas was 40" and the record writing time under distraction was 46" (both made on the same day) it is evident that the two processes never became completely synchronous. On the

adding side, the record normal adding was 15" and the record adding under distraction 18" (made on different days—16" and 20" were records made on same day). In the case of the writing the difference is 6" and in the case of the adding 3". The difference in the writing speed is the time taken to vocalize the verses.

Introspections. Extracts from the introspections made by the subject in the course of the experiment will serve to indicate the process gone through during the experiment.

First, a general summary of the introspections on the normal writing. These concern mainly the cue used for writing. "The cue is definitely vocal-motor, largely word by word, prolonged during the writing, the next word being verbalized just as the last stroke of the preceding word is being finished. There is a certain foreflitting of words that is too shadowy to serve as a cue. The unit for meaning is line by line, while the unit for the cue is word by word or, where words are very short, phrase by phrase. This makes it difficult to introspect the cue, as the meaning sometimes makes it seem as though it were coming line by line. When thinking about the cue, there is a tendency to cut the cue unit." From the beginning of the taking of normal writing to the end, a constant tendency for the verse cue to become less and less distinct is apparent.

The introspections concerning the cue made on the writing under distraction, are, in brief, as follows: first day,—“Verse verbalized completely, with the last words of each line verbalized a second time; for instance, the 4th line was first verbalized as a whole and then ‘pleasant land’ was repeated about the time I reached ‘pleasant’ in the writing;” second, third and fourth days,—“Vocal-motor cue for the verse;” fifth day,—“Cue for writing drops out in places. Writing report is not clear;” sixth day,—“Vocal-motor cue less noticeable than before. Grapho-motor report is lost;” seventh day,—“Vocal-motor cue definite but not very clear;” eighth day,—“Vocal-motor cue for writing more blurred than before. Some unawareness of writing but vocal-motor cue for verse throughout;” and ninth day,—“Vocal-motor cue for verse only at intervals. No remembrance of writing cue as a whole.”

The introspections concerning the synchronization of the two processes are self-explanatory. They show, also, the gradual development of proficiency in handling the complex situation.

First Day. “Attention mainly on addition. Some flickering

of attention. Adding seems to be in part visual. Conflict between two activities is largely on a vocal-motor basis."

Second Day. "Two processes were not synchronous, although in the first verse slight tendency to synchronization is noticed. While writing, the adding was merely held in mind, except once or twice where small figures were added. Attention is largely on the adding. At certain places, doubling of the vocal-motor process seems to take place."

Third Day. "Attention more on adding than writing. Adding is in part visual, in part vocal-motor. Number of figures taken in by the eye at one time is growing. Habit of making additions without revision is forming. Writing comes in the adding breaks. Pause in adding comes after the first three numbers in the columns. Processes do not seem at all synchronous."

Fourth Day. "Considerable fluctuation of attention. Hand is never forgotten except when not moving. Adding seems more visual than before. At beginning of the column the writing and adding seem synchronous, then as adding becomes more difficult, the writing is stopped." (Experimenter's observation, "No writing of verse while A is speaking.")

General Introspection. "I start writing the verse first, giving a definite vocal-motor cue for the first line, then when the hand is on its way, start the adding, which at first runs along with the writing, both having a vocal-motor cue. The numbers are a mere flicker or shadow above the well-defined writing cue. But as the process grows more difficult, it tends to take over completely the entire vocal-motor process and the writing stops. When I get to the end of the column, the adding being over and the result announced, I give a second definite vocal-motor cue for the writing. Again the two processes run on synchronously for a while, with the adding gradually taking up the entire process. When I get through adding the first problem, I become conscious of having written only a small part of what should have been written, and spurt, paying a little more attention to the writing than to the adding. Then again the adding comes to the fore."

Fifth Day. "Synchronization never occurs for more than half a column. Attention is largely on the adding but there is a little more synchronization than before. Attention fluctuates. Practise effect is beginning to show on the adding. Adding has become more visual. Writing half drops out in places."

Sixth Day. "Processes are more synchronous than before. Adding is becoming visual. Much synchronization. Writing tends to drop out and attention goes to the adding."

Seventh Day. "Very difficult to-day." 1. (first writing time). "Processes don't synchronize." 2. "Slight synchronization." 3. "Processes synchronized throughout the first verse and first two lines of second. Visual adding is not noticeable. Unit of addition is growing bigger."

Eighth Day. "Processes well synchronized. Writing and adding went on together. Some unawareness of writing. First problem was well synchronized with writing."

Ninth Day. "Attention chiefly on adding. Some fluctuation of attention. Lapse of hand-awareness for long stretches. Hand innervation comes more easily than earlier in test."

Tenth Day. "Went very easily. Synchronization throughout. Adding seems a trifle more visual than before. Large adding units are taken in at a glance."

Eleventh Day. "Very little attention on the verse." (Experimenter's observation, "Results now announced while A is writing.")

V. READING ALOUD AND WRITING

Method. The conditions under which this test was tried were, for the most part, similar to those of the third section except that the reagent read aloud instead of reading silently. In order to test the memory of what he had read the reagent stopped writing at the close of every verse, or, on some occasions, at the close of every third or fourth verse and gave what he could recall of the contents read. He also gave his introspections and reported any lapses in the writing that he remembered. Breaking the writing at frequent intervals made it possible to determine the exact number of words read during any particular period, and insured a fairly accurate equating of the amount read and the amount written at any particular time. In this respect the records are more satisfactory than those of the second section. Moreover, since the introspections were given at shorter intervals they are probably more adequate than before, although the frequent breaks may have prevented a gradual absorption in the reading and contributed to a heightened capacity for handling the double process through extreme concentration of attention for a short period.

As before, the speed with which the verse was written was timed. Normal reading-rates were obtained at the beginning and toward the close of each session. Normals for writing speed we obtained one at the beginning, the other at the close of the session, alternating as first or second the normal written with the screen and the one written without the screen.

The experiment ran for twenty-three sessions, Subject A served as reagent.

Results. The growing ease with which A handled the situation is indicated by Table VI which shows, first, the increase in the number of words read per second, and secondly the gradual increase in the rapidity with which the verse was written; a rapidity, toward the close of the experiment, approximating the normal writing-time.

TABLE VI
READING ALOUD AND WRITING. REAGENT A

Reading	Date	Words read per second				Time of writing verse				
		Normal	Distraction			Normals	Distraction			No. of times written
			Av.	Max.	Min.		Av.	Min.	Max.	
"The Intruder"	Dec. 18	No record								
Scientific reports	Dec. 19	"	2.31	2.90	1.92	39.0	71.21	49.5	111.0	7
"	Jan. 12	"	2.43	2.73	2.03	38.5	63.83	56.0	72.0	6
"	Jan. 13	"	1.67	1.98	1.48	41.0	80.37	72.5	90.0	4
"	Jan. 14	3.33	1.74	2.36	1.35	40.5	63.50	57.0	66.5	10
"	Jan. 14	3.38	1.83	2.12	1.50	39.5	61.90	60.0	65.0	5
Phillip's "Genesis of Number Forms"	Jan. 15	3.38	2.16	2.55	1.81	42.0	62.35	56.0	71.0	10
"	Jan. 16	3.45	2.38			41.0	58.00	53.0	72.0	8
"	Feb. 3	3.55	2.27	2.58	1.95	41.0	64.29	56.5	71.4	7
"	Feb. 4	3.33	2.03			40.7	55.29	44.0	67.5	8
Sanford, "Psychic Research in the Animal Field"	Feb. 5	3.34	2.39	2.65	2.13	38.4	55.09	50.0	61.0	9
"	Feb. 9	3.53	2.15	2.40	2.01	40.0	55.73	51.2	58.1	7
"	Feb. 10	3.91	2.48	2.59	2.36	36.0	51.55	48.0	54.0	11
"	Feb. 11	4.00	2.84	3.13	2.53	38.4	46.65	43.2	52.0	7
"	Feb. 13	3.76	2.61	2.91	2.30	35.5	47.78	43.0	55.5	6
"	Feb. 16	3.63	2.58	2.96	2.36	38.0	49.71	44.7	53.6	6
"	Feb. 17	3.83	2.85	3.03	2.40	33.7	44.65	42.4	46.5	7
"	Feb. 18	4.13	3.21	3.55	2.91	36.7	43.50	40.7	46.8	6
"In the Wireless Room" (story)	Feb. 19	4.26	3.07	3.43	2.84	35.8	47.95	45.0	52.5	6
"	Feb. 20	4.03	3.54	4.25	3.89	36.0	43.57	40.1	45.4	7
"	Feb. 24	4.25	3.24	3.83	2.65	38.0	43.15	40.5	46.0	8
"	Feb. 25	4.17	3.34	3.89	2.80	34.2	41.12	37.1	45.4	8
"	Feb. 26	4.71	3.75	4.00	3.32	36.1	39.19	35.0	43.8	9
"	Feb. 27	4.91	3.62	4.01	3.13	33.0	37.96	34.5	45.5	9

⁸ Speeding with screen.

Introspections. On the introspective side there was reported a gradual increase in the ease with which the double process could be maintained. At first there was very little synchronization of processes. Breaks would occur in the reading, during which A would get his vocal-motor cue for the writing. These fluctuations in attention were very rapidly and skillfully executed. Frequently, A spoke of getting a general "set" for the two processes before beginning writing or reading.

A bad initial "set" caused breaks in the process, so, too, any interference while the writing was in progress. Such interference occurred when there was difficulty in getting the

meaning of what was read, when there was difficulty in pronouncing a word, when the paper slipped however slightly, or when the experimenter touched A's hand. On several occasions the entrance of someone into the room where the experiment was being conducted caused bad breaks in the process. These breaks were evidenced not only by A's report but also by the slowing of the time of writing and, usually, by a repetitionary lapse. Such breaks show also the tension created by the situation. Greater ease in writing the first three lines seemed due to persistence of initial set through that point. After that there was tension.

At the fifth session A reported that the kinaesthetic "report" was lapsing. From this time on, there were reports of increasing ease in handling the situation, there was also increasing excellence in the memory of reading-contents. A's reliance upon the kinaesthetic report was shown by the difficulty he had in handling the second and third lines, both of which commenced with a capital a. A repeated feeling of doubling or omitting one of these lines seemed so determined.

The experiment ran a long time before A reported any synchronization of the two processes. The growing ease in handling the situation seemed due, not to synchronization, but to the fleeting character of the vocal-motor writing cue. In time, too, the cue was cut in that one word or letter could serve as the cue for several words. Not until the thirteenth session did A report synchronization of processes. He began to describe the writing cue as floating over the reading. In the course of this session the writing became "fast and furious." At the next session A began to complain that meaning was evaporating from the verse he was writing, so that if a break occurred he had difficulty in picking up his cue. Later still he reported, "Cue seems to come after not BEFORE the word is written. It is definitely on top of the reading process." Again, "The two processes are definitely synchronous. Lines seemed shoved together, telescoped. Not enough words. What's gone?"

The reading varied from expressive reading to reading that was very monotonous or breathy. With a shift in style, as one article was changed for another, there was for a time increased difficulty in handling the problem which indicated that in part attention-habits, induced by familiarity with style, were operative in increasing speed of reading. The normal reading-rate also showed a progressive increase, not only within the scope of a single article, but also in the experiment as a whole.

The final experiments in this section were carried on while A was reading a very interesting story. Toward the climax of the story there was a strong inclination to stop writing altogether.

VI. READING ALOUD AND WRITING FROM DICTATION

Method. There was little change in method. As before the reagent sat to the left of the screen with his arm, extended through the sleeve, resting on the writing-pad, while the experimenter, on the other side of the screen, manipulated the writing-sheets, dictated material, and timed the reading and writing. The reagent read aloud continuously from a story while writing from continuous dictation, words given, that is, one at a time as rapidly as the reagent could write them. At the close of set intervals, varying from one to three minutes, with an occasional five minute period, the reagent was stopped and the experimenter recorded (1) the subject's memory of the contents read, (2) his memory of the matter dictated, (3) introspections as to the course of the experiment. In the second half of the experiment his memory of the contents dictated was recorded first and his memory of the contents read taken after that. Record was made of the number of

TABLE VII
READING ALOUD AND WRITING FROM DICTATION
Reagent D

Story	Date	Normal	Distraction			
		Average number of words read per second	Average number of words read per second	Average number of words written per minute	Average number of words remembered	Length of writing interval
R. H. Davis' "In the Fog"	Mar. 30	4.03	3.07	20.00	3.0	1 min.
	Mar. 31	3.83	3.18	19.85	3.1	1 min.
	Apr. 1	4.86	3.46	16.25	1.5	3 min.
	Apr. 2	4.75	3.63	18.22	1.4	3 min.
	Apr. 3	4.91	3.98	17.44	2.1	3 min.
	Apr. 6	...	3.53	15.88	1.7	3 min.
	Apr. 7	5.00	3.86	17.90	.9	3 2(5)
	Apr. 8	4.50	3.67	15.94	.7	3 4(6)
Davis' "A Derelict"	Apr. 27	4.08	3.13	18.58	1.2	3 min.
	Apr. 28	3.83	3.32	16.73	1.1	3 min.
	Apr. 29	4.01	3.43	18.06	1.2	3 min.
Davis' "La Lettre D'Amour"	Apr. 30	4.18	3.76	18.94	.9	3 min.
	May 4	4.95	4.00	20.77	1.6	3 min.
Davis' "The Man With One Talent"	May 5	5.18	3.98	17.83	1.0	3 min.
	May 6	5.76	4.60	21.22	2.7	1 min.
	May 7, a.m.	5.35	4.92	22.85	3.4	1 min.
	May 7, p.m.	5.65	4.66	22.33	1.3	1 min.

words read aloud and of the number written from dictation each minute. At the beginning of the session and sometimes toward the close a record was made of the normal rate of reading aloud. Both A and D served as reagents.

Results. As before, the tables (VII and VIII), show the effect of practise upon the reading-rate. There is a fairly constant increase in speed for both the normal reading and that under distraction. The introspective records show that subjectively, the reagents found the experiment an exceedingly easy one to carry out but in spite of this the reading with distraction failed to reach the normal speed. The number of words written per minute⁹ is well under that which can be taken in normal conditions, and, curiously, there is little evidence of any tendency to an increase in the number of words taken per minute. A's record would seem to indicate a tendency to decrease, D's record at the point of greatest reading speed is higher than the average. Throughout, the record for the first minute is consistently higher than that for subsequent minutes, as though during the experiment the reagent "ran down." Both reagents had a good memory of the contents read but A's report was considerably more detailed than D's. There were times of curious lapse of memory of details, both reagents reported a feeling of having them just on the tip of the tongue and then losing them. A's memory of the

TABLE VIII
READING ALOUD. WRITING FROM DICTATION
Reagent A

Story	Date	Normal	Distraction			
		Average number of words read per second	Average number of words read per second	Average number of words written per minute	Average number of words remembered	Length of writing interval
Davis' "The Bar Sinister"	Mar. 2	4.66	2.28	22.7	9.1	1 min.
	Mar. 3	4.02	3.20	19.8	9.4	1 min.
	Mar. 5	?	3.26	25.0	7.0	1 min.
	Mar. 6	4.58	3.19	19.3	1.0	3 min.
	Apr. 9	4.66	3.88	19.5	1.5	3 min.
Downey's "The Ghostly Sting"	May 7	4.60	3.70	21.0	7.1	1 min.
	May 8	4.40	3.65	19.2	10.0	1 min.
	May 11	5.3	4.48	17.5	6.1	1 min.
Davis' "The Editor's Story"	May 12	5.15	4.02	18.3	6.0	1 min.
	May 14, a.m.	5.00	4.46	17.2	5.2	1 min.
	May 14, p.m.	5.06	4.49	17.6	5.0	1 min.

⁹ The number of letters written per minute was also recorded, but to both reagents the word appeared to be the actual unit.

words written was much more complete than D's. It is significant that just about as many words could be recalled at the close of a one minute interval as at the close of a three minute or longer interval. D lost, or failed to make, connections between words much more significantly than A. On one occasion when the experimenter dictated an interesting bit A repeated the whole (twenty-one words), without a mistake, at the close of the writing. He even criticized the use of certain terms by the author of the story. It is true that his reading-rate on this occasion was somewhat retarded and his memory of the contents less complete than usual. When the experimenter tried dictating a sentence twice, A noticed this and gave many of the words that had been redictated. D, on the other hand, failed to recognize the dictation of such a familiar line as "My country 'tis of thee," a failure which clearly evidenced the absolute lack of connection between the words dictated.

Introspections. Both reagents found this task a very simple one, requiring little effort, but from the first there were some differences in their reports. D failed completely to make connection between the words dictated although reporting that while writing each word she knew, with rare exceptions, what it was. At the close of each interval she seldom recalled more than four or five isolated words. A, on the other hand, in the earlier sessions remembered many more of the words dictated, there were occasions when he had an exact memory of both what was read and what written. Moreover, in the first tests at least, he caught the drift of the story that the experimenter was dictating to him.

At first, A repeated after the experimenter the words that were dictated, later such a tendency to repetition dropped out, on some occasions a verbal flicker (vocal or imaginal) seemed to follow the dictation. D reported no such tendency to repetition of words dictated but noted occasionally a faint visual flicker of a word written. Both subjects reported that the experimenter's voice sounded faint, far-off, muffled, even when the experimenter was speaking very loudly and emphatically.

Throughout these tests A reported, "I get the words, as they come, in their connections but they are lost very quickly." Toward the close he caught only phrasal connections. As A reached the climax of a story there was loss of writing control and failure to get the connection between words but the writing did not become completely automatic. When greatly interested in the story there was some tendency for A to stop

writing, the experimenter had to dictate very loudly and at times had to dictate a word several times with great emphasis before it would be taken. Sometimes A reported that a word was heard and written, and that was all there was to it. There was, however, a tendency for him to become alert to the writing. This occurred when the subject-matter especially interested him.

D's reports are more important from the standpoint of automatism. A few extracts from her reports may be given. March 30. "No idea what the story dictated is about." March 31. "Part of the time a feeling of divided attention. Sometimes, half lose the experimenter's voice." April 1. "Words written fuse with story. Once or twice words were written automatically. Difficult to introspect. Lost consciousness of hand once or twice. Extraordinarily little consciousness required for writing. Words dictated often call attention to the writing, so too do any unusual words." April 2. "Lost consciousness of writing. Just get voice." April 8. "There are times when writing is pretty nearly automatic, times when I do not know what words are written." April 27. "Drop in kinaesthetic report. Feeling of irresponsibility as to details." April 28. "Very little writing consciousness but I know the words while writing them. Sometimes lost meaning of word dictated. In places a tendency for the reading to become automatic." April 29. "Words have no meaning. Wrote a few words without return report from hand." April 30. "Feeling of complete uncontrol. (Writing is indecipherable.) Forget words while writing them." May 4. "Can't spell words dictated, they vanish too soon." May 6. "Tendency to forget words in middle, memory seems to hold over about four letters." May 7. "Heard word and wrote it, nothing more. Some very easy words seem to be written unconsciously."

VI. A SUPPLEMENTARY EXPERIMENT

Silent Reading and Writing from Dictation

Because of the fact that our reports showed so much more evidence of conscious control than did the report of Solomons and Stein¹⁰ under somewhat similar conditions, we tried a supplementary test in which we attempted to conform to their conditions. We substituted silent reading for reading aloud, we gave up speeding, we let the writing run on for long inter-

¹⁰ L. Solomons and G. Stein, Normal Motor Automatism, Psychol. Rev. III, 1896.

vals until fatigue set in, we slowed the rate of dictation, instead of making it continuous, between dictations we fell back on meaningless strokes, we no longer called for reports on the memory of what had been read. No significant change occurred, however. The experiment simply took less effort than before. Although D continued such writing for nearly two hours (two sessions) there was no report of greater automatism than in the preceding test. On the last day, when she was feeling unusually fit, she remembered more of the words written than ever before, recognized redictated sentences, and that without the slightest consciousness of effort. The most significant lapses under these conditions occurred in the case of A, as follows: first, his failure at times to take a word until it had been dictated several times; second, long retardations in taking words without, however, a redictation; third, the repeated writing of a word although it had been dictated but once, because, as he explained, he could not remember whether he had written it at all.

VII. GENERAL SUMMARY AND CONCLUSIONS

I. *Normal Rapidity*

As the experiment continued there was a continuous increase in the normal rapidity for all operations tested, so that the question arose whether we could count on having ever reached a permanent record. This increased speed in the case of reagents already practised in the operations in question is interesting. It depended undoubtedly upon the effort put forth, the definite intention to speed to our limit. As Book and other investigators of the learning process have shown, effort of attention makes for greater efficiency.

Writing Normal. For reagent D the time required for writing the first verse ("Thirty days," etc.), fell from 60.6 seconds to 54.2 seconds. These normals were taken without the screen and in pencil. They represent little practise except in so far as the writing of the verse under distraction served to lower the normal time record. This is a good speed, equivalent, for the verse written, to more than two letters per second.

For reagent A we have at hand a much greater number of records both with and without the screen. The slowest record without the screen for thirty trials, on thirty different days, was for the first verse 44 seconds; the fastest, 33.5 seconds. With the screen, the maximum was 42 seconds and the mini-

mum 33 seconds. The average of the last six trials with the screen was 35.5 and without the screen 36.7. These records are very rapid ones, from over three to more than four letters per second. The best records would be made unexpectedly and then, in time, this record would become an average one. Such increase in efficiency even after the limit would seem to be reached is common to all practise curves. It is probable that A reached his physiological limit in speed; he had long passed the limits of legibility. The verse-cues served to release a series of movements that were cut in every possible way. A tried, deliberately, methods of shortening his time; he tried, for instance, the effect of decreasing the space between lines, diminishing letters, etc. The fact that the record with the screen stayed pretty constantly below that made without the screen shows the curious inhibition from the visual report even before the limits of legibility were passed. With the second verse written we have again an increase in speed with practise, with a higher speed achieved with, than without, the screen.

Reading-normals. D's rate in silent reading estimated from thirteen normals varied from 6.3 words per second to 7.4 words per second. A's, estimated from the same number of normals, varied from 8.6 to 12.5 words per second. Both records are good (A's unusually so) if we may judge by comparison with the reading-rate for twenty-eight persons given by Huey, who writes, "When the silent reading was at maximal speed, the rates ranged from 3.5 to 13.5 words per second."¹¹

The reading-speed, as the writing-speed, showed a tendency to continuous increase, but this tendency was complicated by two other factors: (1) The effect of the contents read upon the speed of reading, with great rapidity at points of climax, and (2) the effect upon reading-rate of familiarity with a writer's style.

The general tendency toward increase in reading-rate seemed in D's case due to inhibition of certain general habits. Many things have operated to reduce D's speed in reading such as close grammatical work on the classics, critical reading, correction of students' themes. She developed during the practise some power of inhibition of a habit of criticizing details and pausing over generalizations. She also inhibited, in part, a tendency to indulge in concrete visualization of descriptive bits. A's increase in speed would seem due, in

¹¹ "The Psychology and Pedagogy of Reading," pp. 174 f.

part at least, to an achievement of a certain amount of visual reading. If we may trust A's introspections he handled the double process to a certain extent by getting the meaning of what he read visually and thus releasing the articulatory process for control of the writing. Pintner¹² has shown that, with practise, reading without articulation may be acquired when the articulation of what is read is artificially inhibited. He reports, further, "That practise in reading without articulation tends to aid ordinary reading, most probably by shortening the habitual visual reading." In the same way A carried over into the normal reading habits acquired during the reading from distraction.

As was said before no effort was made to test the memory of what was read but both reagents followed the story with interest.

The rate for reading aloud was obtained on sixteen different days for D. This ranged from 3.83 to 5.65 words per second. For A we have thirty normals obtained on as many different days. His rate ranges from 3.3 to 5.15 words per second. Such reading rates are excellent. To quote Huey again,¹³ "In reading aloud, the average of the slowest reader was 2.2 words per second and that of the fastest 4.7, at the ordinary rate, and at maximal speed the corresponding range was from 2.9 to 6.4 per second."

The tendency to progressive increase in the rate of reading aloud is perfectly evident although, as before, interest in contents and familiarity with an author's style affected speed. D's record, given in connection with the dictation experiment (Table VII), shows that between the eighth and ninth records a break of more than two weeks occurred. Following this break there is a series of low records. These low records may be due to the break in practise but, more likely, are to be attributed to the bad physical condition of D at the time. With improvement in condition, May 30, there came rapid improvement.

The increase in the normal rate of reading aloud was due very largely to improved methods of breathing. Both reagents lowered their voices in the later experiments and there was some tendency to blur enunciation. D's enunciation is more distinct than A's. Relatively her reading aloud is much more rapid than her silent reading. It is difficult to explain this

¹² "Inner Speech during Silent Reading," *Psychol. Rev.* XX, 1913, pp. 129-153.

¹³ *Op. cit.*, p. 175.

unless the sound of her own voice acts as a spur to attention. This may well be the case as D is unusually sensitive to auditory stimulation. A, on the other hand, pays no attention to the sound of his own voice and finds that reading aloud disturbs the tendency to visual reading. A found at times a tendency to glance ahead and get the meaning before resorting to the slow reading aloud.

D was able to verbalize mentally the test-verse more rapidly than could A. Possibly the fact that D's inner speech is auditory-vocal-motor and that A's is vocal-motor accounts for this. The range for A (14 trials, different days), is from 3 to 6 seconds. For D (6 trials), from 2.5 to 3 seconds.

It is obvious that the progressive increase in the speed of the normal operations introduces some difficulty in interpreting the results under distraction, for a record under distraction that approximates the normal for the day may yet be far from the normal that might be reached under sufficiently high concentration of attention. Only if a fairly constant normal were attained, one obviously approximating a physiological limit, would we have at hand a satisfactory standard for checking the rate under distraction. In the time at our disposal it was, however, impossible to carry the experiment out to such an extreme. A's writing record on the first verse (33 seconds) may, however, be taken as a satisfactory limiting value. The final normals for reading aloud must also be very close to the physiological limit for the readers in question as evidenced both by the effort involved in the spurting and by the tendency to slur words.

2. *Rapidity under Distraction*

In the course of the discussion we have already indicated the general bearing of distraction upon rapidity. In the first place we find with practise a progressive increase in the speed with which reading and writing (or reading and adding) could be carried on. All the tables could be converted into characteristic learning curves. A consideration of the bearing of this fact upon the general interpretation of results will be attempted later.

Let us now summarize the facts recorded relatively to the speed of work under distraction.

In the test on simultaneous writing and silent reading there were several instances where A's most rapid rate of writing for the day was within a second of his normal record, or, more correctly, since the normal was taken without a screen, within two seconds of the normal. There are cases where

the most rapid record is the same or lower than the normal and the average time only slightly (two to three seconds) above the normal. Toward the close of the tests, the mean variations on the time-records were very low. There were also some very high reading-rates. Thus, in reading Chapter VIII of "The Abysmal Brute" under distraction A reached his second highest speed record for that story, a very high speed, something over eleven words per second. No doubt A's ability to read visually served the purpose of releasing the vocal-motor process for control of the handwriting. The average writing speed for this day is within three seconds of the normal. Since A's writing-habits are exceedingly well-organized and smooth, the only thing needed for maintaining the writing of the verse was a schematic and rapid vocalization of a few words. To this we must add also a capacity for extending the scope of attention.

D's writing-speed under distraction approached the normal less closely than did A's. The best records are found in Table II. For "The Abysmal Brute" the best average is ten seconds higher than the normal, and the record speed under distraction at least 4.8 seconds higher than the normal. In "The Game," the best average is about three seconds above the normal but there are one or two individual records below the normal. Very great retardation is evident for the poorest records. On account of her slower reading D wrote the verse a much greater number of times than did A but in spite of this failed to reach a constant reaction as soon. Had the experiment been continued with her she would have reached, probably, a more constant reaction. Her writing-habits are, however, much less mechanized than A's and her span of attention narrower. Under distraction her reading-rate in no case approximated the normal.

Let us turn now to A's record for writing while reading aloud. Between this experiment and that of silent reading the adding test intervened so that more than a month's time separated the two reading tests. In order to make the two series of records comparable the verse written in the silent reading test was again employed. It is interesting to note that the normal time for writing this verse began in the later series well towards the lower limit of the earlier series. The retardation of the speed under distraction shows, however, that reading aloud while writing, is a very much more difficult thing for A than is simultaneous silent reading and writing, no doubt because of the inhibition of visual reading.

In part, however, at least toward the close of the series A still had recourse to visual reading since he would glance back to take in the meaning, then resort to automatic vocalization of the words read while concentrating for a short period on mental vocalization of the verse. The initial record in this series is much higher than that in the first series. The experiment ran nine days before A reached an average writing speed as rapid as that reached on the first trial with silent reading. Toward the close of the series he made, it is true, an even better time-record under distraction than in the preceding series since once his verse-time fell to 34.5 seconds as against 39 seconds in the other. During the course of the experiment the normal time had, however, been constantly falling, so that the best record under distraction is 1.4 seconds above that day's normal record, while the best averages are from three to four seconds above the normal. A much greater variation in speed than occurred in the preceding series is also evident. The worst records show considerable speed retardation. A's reading-rate during writing is in this test considerably retarded, relatively much more so than the writing speed. There is, even in the fastest records, a loss of about a word per second. It would seem that the conditions of the test introduced a certain amount of vocal-motor conflict. The inner verbalization of the verse required from three to six seconds for A, hence a retardation of reading-speed from twelve to twenty-four words every verse-time (something over thirty seconds) would serve to keep the processes going. The retardation of reading speed is just about what would be required. Throughout, A's memory of what was read was excellent.

In simultaneous writing and adding A's writing-speed is retarded six seconds at least, and the adding speed at least three seconds. It is interesting that again the retardation in adding should be just about that required for thinking the verse.

In the experiment on taking dictation while reading aloud neither reagent approximated the normal reading-rate and that too in spite of the fact that both reagents felt the task to be a fairly simple one and made every effort to speed the reading.

3. *Graphic Lapses*

A careful tabulation was made of the graphic lapses occurring during simultaneous writing and reading and much material has been collected for subsequent study. At present

we shall confine ourselves to summarizing the general observations.

D's lapses during silent reading and writing were surprisingly few in number but significant in character. Often verses were written without a single lapse. At most, if we omit line-lapses, four lapses per verse occurred. The lapses that appeared were stereotyped. Such a stereotyped lapse occurred in the doubling of "v" and the repetition of the first letter-stroke of "y." The kinaesthetic report for these letters was absolutely lacking. Even after D was informed of such a lapse and attempted to inhibit it, it kept reappearing. This loss of kinaesthetic report on certain letters is curious. At times D reported, incorrectly, that she had dropped lines. Such omission actually occurred on occasion. Quite the most significant lapse that was noticed throughout the whole experiment for either reagent was the omission of a line in one verse with its repetition in the verse immediately successive (some sixty seconds later) without D's knowledge of either lapse.

A gave a great number of lapses for every verse. In the experiment on writing while reading silently these lapses consisted for the most part of lapses of omission such as the cutting of strokes, the omission of letter-parts or of letters and words, lapses similar to those which occur in his normal rapid writing, probably indicative of anticipations on the part of attention which keeps ahead of the writing. Line-lapses of omission or repetition were usually reported by A at the close of the verse. The number of omissions of letter-parts and of letters gradually increased throughout this series as a whole. Many omissions became stereotyped and a given word presented a progressive cutting of strokes. Thus "February" appears successively as "Febrary," "Febray," "Febry" and "Febu." Toward the close of this series of experiments repetitionary lapses and lapses of substitution began to appear. There occurred also a curious exchange of letter-parts, a lapse purely motor in origin.

With the shift from silent reading to reading aloud a most interesting change occurred in the kind of lapses that were most frequent. The repetitionary lapse appeared again and again. This lapse evidences the attentional conflicts and, perhaps, also some difficulty with the kinaesthetic report. An exchange of letters as well as of letter-parts appeared; thus, "April" became "Aprli." Hybrids, due to fusion of two words are found; thus, "gives twenty" becomes "gventy." The repetitionary lapses showed a tendency to become stereotyped as had the omission-lapses in the preceding series.

On the fifteenth day of this experiment the repetitious lapses began to drop out noticeably and the old lapses of cutting strokes and omission of letters reappeared. Such a shift in kind of lapse evidences, as did the introspective report and the increased rapidity of writing, the growing skill with which attention handled the double process.

The shift from repetitious lapses to lapses of omission in this second series is more easily understood than the tendency in the simultaneous writing and silent reading to shift toward the close of the series from lapses of omission to repetitious lapses. Possibly in this later case the distraction has become so complete and the verbalization of the verse so cut that attention to the writing came only in jerks and at very infrequent intervals. The experimenter found that she could produce these lapses of repetition almost at will (without A's knowledge of the occurrence) by the simple device of moving the paper gently or of lightly touching A's hand. Such artificial production of lapses promises much in the way of future understanding of them.

Throughout the course of the experiment A was able by thinking back over the writing to recall many of the lapses made with surprising accuracy. There were times, however, when he reported a strong feeling of having made lapses which were not found to occur.

4. *Simultaneity of Processes*

We are ready now to raise the question as to the actual *simultaneity* of mental processes during the course of the experiment. Simultaneity of motor reactions occurred. A was able to continue writing, even to start a new word while announcing the results of mental addition, and able to write while reading aloud. It was found, however, that even with the immense amount of practice reported the verse could not be written absolutely mechanically, simply by an unwinding of the movements; some slight control in mental terms was necessary. The mental verbalization of the first verse employed took from three to six seconds—that much retardation of reading-speed would probably serve the purposes of control. We have already indicated that just about so much retardation occurred in the reading-rate under distraction. There is, possibly, one exception, the rate of silent reading of Chap. VIII of "The Abysmal Brute" where A achieved an extraordinarily high reading speed with very little retardation of the writing speed. Here we may have a bit of evidence for actual simultaneity of the mental processes.

Introspectively, we get reports of actual synchronization.

A reported that while he was reading aloud an imaginal vocal-motor cue floated over the overt vocalization of the words read. It is obvious, however, that such a report must be checked by objective records. Still it is possible that the slight retardation in speed noticeable throughout the tests is a general retardation due to the amount of effort needed for keeping the two processes going rather than a specific retardation of either of the operations. The normals were taken with great effort of spurring and the attempt to drive two processes to the limit was very fatiguing.

Two interpretations of our records are, therefore, possible. The first is that two operations may be carried simultaneously with slight loss of speed if one be so mechanized as to require little sensory control; the other is that two mental operations may for a short period be actually synchronized but with a slight loss in efficiency due to the demands upon the general mental (nervous) energy.

The question of speed under distraction is of interest not merely as a check upon the subjective impressions of the reagents but also in connection with certain reports that have been made upon automatic writing. Thus Solomons and Stein write in their report upon "Normal Motor Automatism:" "In all automatism the tendency toward increased speed is marked. Writing tends towards a pace that very quickly tires, reading towards a rapidity that prevents distinct articulation, dictating towards a speed that soon becomes hopelessly fast for the writer."¹⁴ In the above report no records are given of either reading or writing speed so that it is impossible to tell the precise data upon which such a conclusion is based. In our experiments we failed to attain, except in rare instances, an approximation of the normal possible speed. This failure was particularly true in the case of the dictation experiment which resembled rather closely the kind of experiment carried on by the writers referred to above. It is quite true that, subjectively, we had often a feeling of "furious" speed and in the verse-writing tests there are samples of writing showing, at least in the case of A, excessive and flourished movements, but, on the whole, there is evident speed-retardation of some sort.¹⁵

¹⁴ Psychol. Review, III, 1896, p. 507.

¹⁵ Probably a greater rapidity than that of normal writing without speeding does result for certain individuals under distraction. The excitement of the distraction serves to introduce considerable tension; each operation serves as a spurt to the other. But the limits of the NORMAL SPURTED SPEED were not reached, in our experiments at least.

5. *Lapses of Awareness*

Again, in the matter of lapses of awareness our reports are in certain instances different from those of Solomons and Stein who distinguish two forms of lapse, lapse of memory and "real unconsciousness." They write,¹⁶ "The consciousness without memory seems to *approach as its limit*, simply a condition in which the subject has not the faintest inkling of what he has written, but feels quite sure that he has been writing. It shows no tendency to pass beyond this into real unconsciousness. It seems to depend on the lack of associations between different words. And conversely real unconsciousness appears not as a final stage of a gradually decreasing memory, but quite suddenly. It does not seem to depend upon association elements at all."

We cannot affirm any distinction between "real unconsciousness" and "consciousness without memory." We found that sensory control could be reduced to a minimum both in writing a memorized verse and in taking dictation. Moreover, there were instances where the reagents reported a lapse of awareness covering perhaps several words but they were never confident that at the time of writing there had been no consciousness. As the experiment progressed we came to realize more and more the extent to which a reported lapse of awareness might be a lapse of memory instead. Throughout, there was evidence of progressive restriction of memory, failures to make associative connections, dependent very obviously upon practise. Thus in the dictation experiment breaks occurred, first, in sentence connections, then in phrasal connections,—each word became detached. At the close of even a short interval the reagents were able to recall little of what they had written although confident that at the time of writing they had been aware of it. In the case of D the breaks in connection went further. Meaning evaporated from detached words and sometimes in the middle of a word she forgot what it was.

The progressive failures in memory as the reagents learned with practise to concentrate upon reading; the fact that just about as much could be recalled at the close of a one as at the close of a three minute writing interval in the dictation experiment; the gradual loss of meaning, no doubt through breaks in connection; the more evident failures of memory when the reagents were in bad physical condition, led us to

¹⁶ *Op. cit.*, pp. 501 f.

believe that all lapses reported were memory lapses which approached as a limit a completely dissociated mental bit.

It is significant that A, whose span of attention is broader than D's, should have reported less thoroughgoing breaks than did D, and that he should have remembered so much more of the written contents than D, and at the same time have had also a relatively better memory of what had been read. His success in writing the verses while carrying on other operations seemed also dependent upon his ability to remember "where he was at," it was only toward the close that he began to complain that meaning was evaporating from the verse so that if he lost his place he was unable to continue with the verse unless he thought back over what he had written. D made this complaint much earlier.

In the above discussion we are thinking chiefly of the verbal (cue) consciousness. Movement itself may, it would seem, be a purely physiological occurrence but there is no reason why kinaesthetic sensation from hand and arm may not become dissociated as well as any form of verbal imagery. We have said before that A's writing-habits are so thoroughly mechanized and his writing-impulse so smooth that normally the return report from hand and arm does not enter the focus of attention; it is marginal. D, on the other hand, is acutely conscious of the movements of the hand and arm in writing and reported under distraction a drop in kinaesthetic awareness of the hand that was very distressing. With this went a curious loss of spatial orientation, with, on occasion, some strange illusions as to hand-movement. She found it impossible to maintain alignment, which in the successive writing of the verse became progressively more degenerate.

It would seem that neither of the reagents who served in the experiment was of the narrow span of attention that would seem to favor breaks in associative connections and, hence, loss of conscious integration. A's span of attention is probably exceptional. With subjects of a different attention-type more frequent reports of lapse of awareness might have resulted. In any case material is accumulating as to the probability of striking individual differences in the ease with which consciousness may be "restricted" so to speak. The habit of fainting, the varying susceptibility to intoxication, and of amenability to anaesthetics, the varying ease with which individuals fall asleep point to striking differences in the facility with which breaks in connection occur. It was our impression from the whole course of the experiment that a report of unawareness was certainly conditioned by lack of

memory-connections and that, possibly, consciousness itself should be phrased wholly in terms of connection.¹⁷

We may meet at this point a few criticisms which may be urged against our method of attempting to get samples of automatic writing. It may be said that the verse tests were such as to demand conscious control, at least to some degree; or that, on the other hand, the use of a memorized content might have led to an illusion of a complete memory since, after the writing was completed, one knew at least what he was supposed to have written. Moreover, the calling for introspective reports on the course of the experiment may have developed an intention to remember and such an intention is without doubt very influential in determining recall. Asking for a report by the reagent of the words written in the dictation experiment may for the same reason be cited as an error in method. But testing of the memory was, of course, necessary in some form. It may be said that our dictation tests were run for too short a period to permit absorption in the story. We had, however, so trained ourselves that we plunged into the reading without effort. Moreover, in the supplementary test we ran the writing for long periods without obtaining any essentially different results. Except with short periods of work it would have been impossible to check the memory reports for, under the conditions of the experiment, memory of what has been done vanishes with very great rapidity. It is the failure to offer any evidence of the checking of general introspective reports that one feels to be a criticism upon the valuable report of Solomons and Stein.

¹⁷ In certain respects this conclusion as to the character of automatic writing may seem at variance with that reached in my monograph on "Control Processes in Modified Handwriting" (Psychol. Rev. Monograph Series, 37). In that report emphasis was placed upon the kind of control utilized in writing under distraction; here, the emphasis is on the functioning of attention; in the former report the initial response to different sorts of distraction was studied; in this report we have worked on the effect of practise on a double operation. The two investigations are supplementary. I have, however, been impressed during the course of the present investigation by the extent to which certain reports of unawareness are certainly conditioned by failure to make connections and by the value of a limiting conception of a detached bit of consciousness. Certainly, in some curious way, the kinaesthetic side represents the crucial point in the situation. Thus D would seem to offer better evidence for the psychophysiological interpretation of automatism than A. The most important difference in the reactions of these reagents concerns the nature and co-ordination of the motor impulse, with, in addition, some evident difference in the natural scope of attention. (J. E. Downey.)